Journal of Anatolian Environmental and Animal Sciences
(*Anadolu Çevre ve Hayvancılık Bilimleri Dergisi*)
DOI: https://doi.org/10.35229/jaes.1334864

JAES
Year: 8, No: 4, 2023 (612-615)
AÇEH
Yıl: 8, Sayı: 4, 2023 (612-615)

ARAŞTIRMA MAKALESİ **RESEARCH PAPER**

Identifying Trace Element Concentrations in Coastal Seawater in Western Anatolia

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Geliş/Received: *30.07.2023* ***Kabul/Accepted:*** *08.10.2023* ***Yayın/Puplished:*** *31.12.2023*

How to cite: **Akakçe, N. (2023).** Identifying Trace Element Concentrations in Coastal Seawater in Western Anatolia. *J. Anatolian Env. and Anim. Sciences,* ***8***(4), 612-615. https://doi.org/10.35229/jaes.1334864
Atıf yapmak için: **Akakçe, N. (2023).** Batı Anadolu Kıyısındaki Deniz Suyunda Eser Element Konsantrasyonlarının Belirlenmesi. *Anadolu Çev. ve Hay. Dergisi,* ***8***(4), 612-615. https://doi.org/10.35229/jaes.1334864

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Abstract: In this study, we examined seawater from Izmir Bay, Türkiye for its trace element content. Three stations were chosen to carry out our mission. The sample collection process took place between November 2019 and May 2020. We focused on pH levels, dissolved oxygen, total dissolved solids, salinity, conductivity values, and trace elements (Ag, Al, Ba, Cd, Co, Cr, Cu, Fe, Li, Mn, Ni, Pb, Sr, and Zn) concentrations. Trace element analysis was done using an ICP-OES. Trace element concentrations were as follows: Ag (0.4 mg/l), Al (0.47 mg/l), Cu (0.82 mg/l), Li (0.81 mg/l), Pb (0.065 mg/l), and Sr (8.06 mg/l). Meanwhile, Ba, Cd, Co, Cr, Fe, Mn, and Ni levels were below the measurable limits. Our results are generally high when compared with the literature. Industrial pollution sources (cement, metallurgy, iron and steel industries, electric arc furnaces (EAF-Steel), coal combustion residuals (CCRs), and petrol refineries) all cause marine pollution because they leak trace elements into the sea, which consequently accumulate over time.

Keywords: Trace element, marine ecology, pollution, environmental risk, izmir bay.

Batı Anadolu Kıyısındaki Deniz Suyunda Eser Element Konsantrasyonlarının Belirlenmesi

***Sorumlu yazar:**
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Öz: Bu çalışmada İzmir Körfezi'nden alınan deniz suyundaki iz element içeriği incelenmiştir. Üç istasyon amaca uygun olarak seçilmiştir. Örnek toplama işlemi Kasım 2019 ve Mayıs 2020 arasında gerçekleştirilmiştir. pH, çözünmüş oksijen, toplam çözünmüş madde miktarı, tuzluluk, iletkenlik seviyelerine ve iz element (Ag, Al, Ba, Cd, Co, Cr, Cu, Fe, Li, Mn, Ni, Pb, Sr, and Zn) konsantrasyonlarına odaklanılmıştır. İz element analizi ICP-OES kullanılarak yapılmıştır. İz element konsantrasyonları sırasıyla şu şekilde bulunmuştur: Ag (0.4 mg/l), Al (0.47 mg/l), Cu (0.82 mg/l), Li (0.81 mg/l), Pb (0.065 mg/l) ve Sr (8.06 mg/l). Ayrıca Ba, Cd, Co, Cr, Fe, Mn ve Ni seviyeleri ölçülebilir limitlerin altında kalmıştır. Sonuçlarımız genel olarak literatürle kıyaslandığında yüksektir. Endüstriyel kirlilik kaynakları (çimento, metalürji, demir - çelik endüstrileri, elektrik ark ocakları (EAF-Çelik), kömür yakma artıkları (CCR) ve petrol rafinerileri) eser elementleri denize sızdırdıkları ve biriktirdikleri için sonuç olarak zamanla deniz kirliliğine sebep olmaktadır

Anahtar kelimeler: İz element, deniz ekolojisi, kirlilik, çevresel risk, izmir körfezi.

INTRODUCTION

Trace elements are hazardous pollutants that deteriorate marine systems by way of flux, moving capacity, toxicity, and bioaccumulation (Abdel Ghani, 2015). Marine pollutants reach the sea via land. Seawater dissolves both primary and trace chemical contents. Trace elements are affected by diffusion, turbulence, advection, and convection as well as biodegradation. All be they very low in volume, trace element concentrations in seawater indicate the presence of marine environmental pollution (Tiwari et al., 2020). There are three major sources of trace elements in aquatic ecosystems. The first include atmospheric deposition, discharge effluents from rivers, anthropogenic sources, and surface run-offs. The second includes input of components/particles into the seawater from crustal rocks and sediments via various organic interactions (Kara et al., 2015). The third encompasses trace elements flux into oceans and seas from the ocean crust, mid-ocean ridges, hydrothermal vents, glacial meltwater, and Aeolian particles. The main cause of trace element concentrations in sediment is aqua media; therefore, the trace element enrichment rate is related to the renewal of bottom water and residence times of the elements (Smrzka et al., 2019). Trace elements get distributed in seawater based on their nature (Chojnacka and Saeid, 2017). They also have a cycle in seawater and are basic components of aquatic systems (Smrzka et al., 2019).

Our purpose in doing this study is to assess the flux of trace elements to Izmir Bay from several points, at different times. We feel it necessary to demonstrate the risks they pose to the bay and reveal their sources for the sake of making the bay's marine ecological life more sustainable in the future.

MATERIAL AND METHOD

We collected several seawater were collected from three (A, F, and U) points (A: 38º51' 41'' N 27º2' 8'' E, F: 38º44' 58'' N 26º51' 5'' E, and U: 38º22' 6'' N 26º49' 45'' E) along the west Anatolian coast of Izmir Bay, at three different dates (1: November 27, 2019, 2: January 1, 2020, and 3: May 15, 2020). One litre sample was taken 1-meter beneath the surface of the water. The parameters of pH levels, dissolved oxygen, total dissolved solids, salinity, conductivity values were determined. Seawater parameters were measured in situ by multiparameter (WTW portable multimeter). The probs were calibrated before every measurement. Each sample were placed in plastic bottles and transported to the laboratory at Institute of Nuclear Sciences, Ege University. The samples were filtered and diluted with pure water at about 1:10. trace elements using an ICP-OES (A Perkin Elmer Optima 2000 DV): Ag, Al, Ba, Cd, Co, Cr, Cu, Fe, Li, Mn, Ni, Pb, Sr, and Zn. Pre-enrichment was not done in the samples. Therefore, the effect of salinity on ICP measurements was minimized. Several multi-element standard solutions (Merck) were made to contain all metals whose concentrations were between 20 and 100 mg/ml, so that we could calibrate them (Saç et al, 2012). We then measured each element based on their wavelengths: Ag (328.068 nm), Al (396.153 nm), Ba (233.527 nm), Cd (228.802 nm), Co (228.616 nm), Cr (267.716 nm), Cu (327.393 nm), Fe (238.204 nm), Li (670.784 nm), Mn (257.610 nm), Ni (231.604 nm), Pb (220.353 nm), Sr (407.771 nm), and Zn (206.200 nm).

RESULTS AND DISCUSSION

Two factors dictate how much trace element content seawater – natural ecosystem (e.g. atmosphere, marine condition) and anthropogenic input. Their concentrations can range between 10 mmol/kg at the upper end, and fmol/kg at the lower end (Elderfield, 2006). We measured each sample for pH, temperature, salinity, conductivity, dissolved oxygen, and total dissolved solids (Table.1). The concentrations of the following elements were obtained: Ag, Al, Ba, Cd, Co, Cr, Cu, Fe, Li, Mn, Ni, Pb, Sr, and Zn. Our findings were as follows: Ag ((0.41) 0.4-0.44 mg/l), Al ((0.47) 0.43-0.5 mg/l), Cu ((0.82) 0.63-1.16 mg/l), Li ((0.81) 0.79-0.85 mg/l), Pb ((0.065) 0.06-0.07 mg/l), and Sr ((8.06) 7.01-8.61 mg/l). By contrast, Ba, Cd, Co, Cr, Fe, Mn, Ni, and Zn concentrations were nondetectable. We found that our seawater samples contained Sr>Cu>Li>Al>Ag>Pb (in that order) (Figs. 1-2-3). Jian et al (2022) indicated surface water tends to contain Sr>Cu>Pb.

Table1. The parameters of pH levels, dissolved oxygen, total dissolved solids, salinity, conductivity values at the stations on sampling dates.

Stations (A,F,U) and sampling dates (1.2.3)	pH	Dissolved Oxygen (mg/l)	T °C	Total Dissolved Solids-TDS (ppt)	Salinity (ppt)	Conductivity (Ohm)
A1	6.75	1.4	17.7	54.8	39.2	9.25
A2	5.25	9.1	11.9	74	36	9.83
A3	6	10	24	45	37	9.72
F1	6.8	10	20.4	53.3	38.5	9.96
F2	5.5	11.3	11.9	49	34	9.25
F3	6	11	21	55	36	9.54
U1	6.9	10.7	19.3	54	38.8	9.27
U2	6.8	11.7	12.4	58	32	9.03
U3	7	10.5	22	59	33	9.11

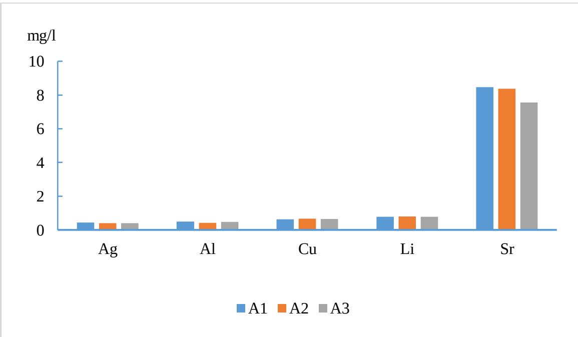

Fig. 1. Concentrations of trace elements in A station on 1. sampling date.

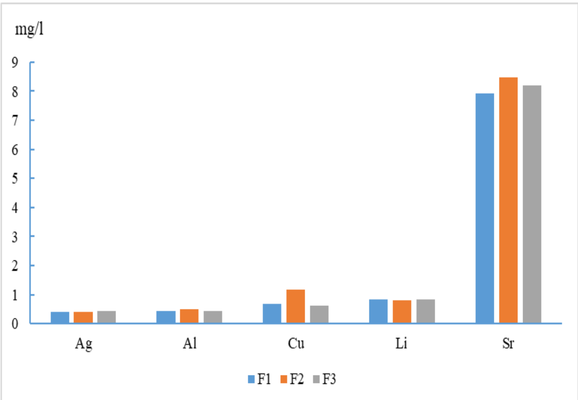

Fig. 2. Concentrations of trace elements in F station on 2. sampling date.

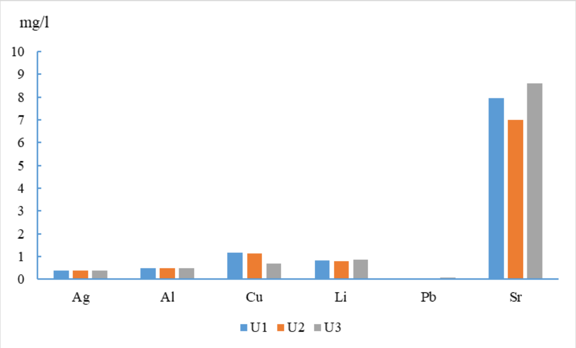

Fig. 3. Concentrations of trace elements in U station on 3. sampling date.

The concentrations of Ag in the ocean can vary between (0.024 and 40) x 10^{-6} mg/l. Ag is very reactive in aqua media, even at low concentrations. Moreover, Ag^{+} is toxic. Al concentrations in ocean and seawater tend to vary between (0.03 and 2) x 10^{-3} mg/l; and can be higher than that at the surface layer of seawater due to atmospheric deposition. Likewise, dissolved Al levels are an important indicator of atmospheric input to the sea. For Cu, oceans can contain 25x10^{-3} mg/l of Cu (range: < (1 – 8) x10^{-3} mg/l). Cu concentration in water depends on the pollution source and water pH. Up to about 80% of Cu levels enters water from anthropogenic sources. When it comes to Li, the worldwide mean concentration of Li in seawater is 180 x10^{-3} mg/l (range: (170 – 200) x10^{-3} mg/l). The worldwide concentration of Pb in oceanic water is between (0.03 and 0.27) x10^{-3} mg/l (mean: 0.03 x10^{-3} mg/l). Annually, between 20 and 40 kt of Pb enters the marine system via riverain and the atmosphere. Sr concentration in seawater is 8 mg/l (mean) and tends to be the most accumulated element in most hydro-organisms (Elderfield, 2006; Kabata & Szteke, 2015). Our data shows that Ag, Al, Cu, Li, and Pb concentrations in Izmir Bay are significantly higher than in other parts of the world; moreover, Sr concentration suits to world limit. The residence time of the trace elements Ag, Al, Cu, Li, Pb, and Sr in water are respectively; 350, 200, 5000, 2.8 10^{6}, 80, and 5.1 10^{6} years (Chojnacka & Saeid, 2017).

Cu and Pb concentrations found in surface seawater samples taken from the coast of the Adriatic Sea range between (1.4-19.7 and 1.3-10.8) x10^{-3} mg/l (Stankovic et al, 2014). Tiwari et al, (2020) indicated that the sea in Goa, India contains 18±5.6 x10^{-3} mg/l of Pb. Kara et al., (2015) discovered the seawater from around the highly industrialized region of Aliağa, Türkiye to be polluted with Al ((101-337) x10^{-3} mg/l), Cu (/0.2-13.2) x10^{-3} mg/l), and Pb ((0.7-10.5) x10^{-3} mg/l). The concentrations of Cu and Pb in Coastal Hawaiian waters range from (0.06-1.04) x10^{-3} mg/l to (0.006-0.04) x10^{-3} mg/l (Bienfang et al, (2009). Pb concentration in seawater from the Persian Gulf, the northern part is 5.38 x10^{-3} mg/l (Pourang et al (2005). Cu and Pb elements concentrations in the seawater of Dingzi Bay, China (inner bay) range between (2.36 and 1.11) x10^{-3} mg/l (Pan et al, 2014). Cu and Pb levels along the west coast of South Korea range between (0.42-1.23 and 0.033-0.091) x10^{-3} mg/l (Woo et al, 1998). In the water of Marsa Matrouh Beaches of Egypt contains 66.47 x10^{-3} mg/l of Al (Abdel Ghani, 2015). Seawater from Sitakund Upazilla, Bangladesh (a major ship demolition area) is polluted with 0.29, 0.011, and 0.113 mg/l of Al, Cu, and Pb, respectively (Hasan et al., 2013). The seawater around the Xisha Islands, South China Sea is riddled with (0.4-5.66, 4848-5725) x10^{-3} mg/l, and (0.05-4.34) x10^{-3} mg/l of Cu, Sr, and Pb (Jian et al., 2022). Surface water samples from bays, ports, deltas and, near the industrialized areas in Zonguldak (Türkiye) show trace elements of Cu and Pb at (2.84-7.73) x10^{-3} mg/l and (5.19-8.02) x10^{-3} mg/l (Çoban et al, 2009). Al and Cu concentrations in Iskenderun Bay (Türkiye) near electric arc furnaces (EAF-Steel) alongside iron and steel factories have been found to be 0.66 and 0.36 mg/l (Göycıncık et al, 2018).

As a result, when we compare our results with other research, we see that our figures are alarmingly high (with the exception of Sitakund Upazilla Coast, whose Al levels rival ours). Beyond that, Sr levels in seawater from the Xisha Islands are comparable with ours, too. The same goes for Al and Cu concentrations in Iskenderun Bay, as well. High concentrations of trace elements in seawater may be assessed to be related to geological structure and coastal pollution (Tiwari et al, 2020). Our sampling stations are close to cement factories, electric arc furnaces (EAF-Steel), ceramic fabrics, coal combustion residuals (CCRs), and petrol refineries. The ceramic industry generates Sr, while Ag is a by-product of petrol refineries (Kabata & Szteke, 2015). Electric arc furnaces (EAF-Steel) release Zn into the environment (Yatkin & Bayram, 2008). Pb hails from cement, metallurgy, the iron and steel industries, and oil combustion facilities (Hindy et al., 1990; Adriano, 2001; Enamorado-Báez et al., 2015; Cereceda-Balic et al., 2020). Al is a crustal element derived from terrestrial sources (Kara et al., 2015).

CONCLUSION

Coastal pollution studies so that experts can ensure marine environmental safety. Trace elements in seawater pose numerous health risks to aquatic life. In this study, we examined concentrations of several trace elements in seawater samples we took from Izmir Bay on different three dates and then assessed their potential aquatic risks. Trace element mounds are only increasing over time, and therefore polluting Izmir's coasts. Industrial pollution is contributing to that risk. More studies are needed on this topic but that focus on a wider area and longer time frame. Scientists also need to investigate what impact trace element pollution via sediments is having on local marine organisms. Likewise, experts and the government need to do more to periodically monitor seawater quality.

ACKNOWLEDGEMENTS

I wish to thank Associate Prof. Dr. İnci Tüney Kızılkaya and Prof. Dr. Şenol Sert for their valuable comments on the study.

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